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Critical Care in Guillain–Barré Syndrome

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Abstract

Guillain–Barré syndrome (GBS) is an autoimmune polyneuropathy characterized by hyporeflexic neuromuscular paralysis and albuminocytologic dissociation in the cerebrospinal fluid. It is a postinfectious disorder. The most common antecedent illnesses are respiratory tract infection and Campylobacter jejuni infection. After the antecedent infection, specific antibodies are generated that cross-react with gangliosides in the host culminating in demyelination of the peripheral nerves or nerve roots. Complement activation also contributes to nerve degeneration. Bilateral symmetrical progression of the limb weakness occurs over a period of a few days followed by a plateau phase, after which a recovery phase follows. Generalized hypotonia and hyporeflexia characterize the limb weakness. Cerebrospinal fluid analysis shows albuminocytologic dissociation. About one-third of patients develop respiratory failure. Neuropathic pain is a disturbing symptom in GBS. Dysautonomia is very characteristic of GBS. Erasmus GBS respiratory insufficiency score predicts the need for mechanical ventilation. The weaning process from mechanical ventilation mainly depends on the recovery of vital capacity and inspiratory force. The definitive treatment for GBS consists of plasma exchange or intravenous immunoglobulin therapy, both of which are equally efficacious. Seasonal variation has been observed in the occurrence and recovery of GBS. Prognosis of GBS varies widely. Erasmus GBS outcome scale scoring system predicts the ability of the patient to walk independently after 6 months. Several GBS cases have been reported globally during recent pandemic of coronavirus disease 2019. Though GBS is a self-limiting disease, there are quite a few research questions that still remain to be answered.

Keywords

- autoimmune disease
- critical care
- GBS
- neuromuscular disease
- ventilation

Introduction

The commonest form of Guillain–Barre syndrome (GBS) is acute inflammatory demyelinating polyradiculopathy (AIDP) that was first recognized about a hundred years ago.[1] Over the last few decades, different variants of the disease have been identified. It is generally believed that GBS is a condition with good outcome. But in reality, 5% of these patients die and 20% of patients have long-term disability. This article is a narrative review of the GBS that is relevant to the intensivists.

History

Descriptions of clinical cases that closely resemble what is currently known as GBS were made as early as 1859, when Jean Baptiste Octave Landry used the term "Landry's ascending paralysis" to describe subacute ascending peripheral sensory and motor dysfunction. Thus, the core clinical features of the condition were described, but its etiology and pathogenesis remained obscure till mid-nineteenth and early twentieth century. It was not until 1916 that Guillain,

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Barré, and Strohl published the paper that would define the disease. In spite of the similarity to what Landry described earlier, no mention of Landry is to be found in Guillain, Barré, and Strohl 1916 article.[2] The three army physicians at the neurological military center of the French Sixth Army described the cerebrospinal fluid (CSF) constituents and tendon reflexes of two paralyzed soldiers. In 1916, Guillain, Barré, and Strohl determined the protein level and cell count in the CSF of their patients. The three neurologists observed high CSF protein levels in the absence of any rise in levels of inflammatory cells described as "dissociation albuminocytologique." This finding was distinct from the high white cell counts seen in the CSF of patients with other prevalent causes of acute flaccid paralysis, such as syphilis or polio. Thus, the finding firmly got established that the condition was a clinical and pathological entity distinct from other infective causes of flaccid paralysis. Initially, Landry Guillain–Barré–Strohl syndrome was used to describe the condition. By 1927, the term had been simplified to GBS, even though Strohl had been instrumental in the electrographical recordings and characterization of the loss of tendon reflexes.

In 1956, Charles Miller Fisher reported three patient case histories; these patients had a triad of areflexia, ophthalmoplegia, and ataxia, and Fisher proposed that they had an unusual variant of "idiopathic polyneuritis." The subacute onset and resolution of symptoms, along with the finding of albuminocytological dissociation, led him to consider the condition to be a variant of GBS with "an unusual and unique disturbance of peripheral neurons." He identified signs that the central nervous system could be involved, which ultimately led to the realization that Miller Fisher syndrome (MFS), Bickerstaff brainstem encephalitis, and GBS represent different points on the same immunopathological spectrum.[3]

Incidence and Variants of GBS

The incidence of GBS in the Western world is from 0.89 to 1.89 cases (median, 1.11) per 100,000 person-years.[4] The incidence increases by 20% per decade of life. In women, immune-mediated disorders are associated with six times higher risk of GBS, rheumatological disorders with seven times the risk, transfusion three times the risk, and preeclampsia two times the risk.[5] Regional variations have been reported in the incidence of various subtypes of GBS. A study conducted by the International GBS Outcome Study Consortium compared the incidence in three regions. In this study, the predominant electrophysiological subtype was AIDP in all regions. The axonal subtype is seen more often in Bangladesh than in Europe/Americas and other Asian countries.[6] GBS occurs less commonly in children compared to adults (0.34–1.34 per 100,000 per person-years).[7]

The most common variants of GBS described are AIDP, acute motor axonal neuropathy (AMAN), acute sensory motor axonal neuropathy (ASMAN), and MFS and its variant, Bickerstaff's brain stem encephalitis (►**Table 1**).

Etiopathogenesis

GBS is a postinfectious disorder. Two-thirds of patients have a respiratory or gastrointestinal tract infection before the occurrence of GBS. *Campylobacter jejuni* (*C. jejuni*) infection is responsible in at least one-third of the patients. Other antecedent infections are cytomegalovirus, Epstein–Barr virus, mycoplasma pneumonia, *Haemophilus influenzae*, and influenza A virus.[8] There are many reports of GBS occurring after vaccinations, surgeries, or stressful events.[9]

Despite the strong association between specific infections and GBS, only one in 1,000 to 5,000 patients with Campylobacter enteritis develop GBS.[10] After *C. jejuni* infection, generation of antibodies that cross-react with specific gangliosides in the host is an important step in the pathogenesis of GBS. Patients with AMAN frequently have serum antibodies against GM1a, GM1b, GD1a, and GalNAc-GD1a gangliosides.[11–15] Patients with MFS have antibodies against GD1b, GD3, GT1a, and GQ1b gangliosides.[16,17] In addition to antibodies against gangliosides, complement activation seems to contribute to nerve degeneration in GBS.[18] This phenomenon has been shown at the nodes of Ranvier and at the motor nerve terminal in a mouse model of AMAN.[19] Sodium channel clusters, as well as paranodal axoglial junctions, the nodal cytoskeleton, and Schwann cell microvilli, all of which stabilize the sodium channel clusters, are disrupted by complement activation in a GBS disease model.[20] In a GBS mouse model, blockade of complement activation prevented occurrence of the clinical signs of antiganglioside-mediated neuropathy. The development of GBS after a clostridial infection may also depend on patient-related factors.[19–21]

Vaccination and GBS

Vaccine-related GBS was reported in about one in 100,000 in 1976 and 2009 vaccinations against influenza A (H1N1) in the United States.[22,23] But national and international studies found that the vaccination was associated with only a small attributable risk of GBS (1.6 excess cases of GBS per 1,000,000 vaccinations). Therefore, the current understanding is that vaccination is safe in patients who developed GBS more than 3 months ago.

Diagnosis

National Institute of Neurological Diseases and Stroke criteria are widely used to diagnose GBS.[24] A history of upper respiratory infection or diarrhea precedes the illness by 3 days to 6 weeks. Numbness, paraesthesia, weakness, and pain in the limbs are the first symptoms of GBS. Bilateral symmetrical progression of the weakness occurs over a period of 12 hours to 28 days when a plateau phase is arrived at. The plateau phase lasts from days to several weeks or months, after which a recovery phase follows. In this phase, about one-third of patients are able to walk; about 25% of patients are unable to walk and require mechanical ventilation. Despite definitive treatment, about 20% of severely affected patients are unable to walk at 6 months. Generalized

Table 1 Variants of Guillain–Barré syndrome

Type	Symptoms	Population affected	Nerve conduction studies	Antiganglioside antibodies
Acute inflammatory demyelinating polyradiculoneuropathy (AIDP)	Sensory symptoms and muscle weakness, often with cranial nerve weakness and autonomic involvement	Most common in Europe and North America	Demyelinating polyneuropathy	No clear association
Acute motor axonal neuropathy (AMAN)	Isolated muscle weakness without sensory symptoms in less than 10%; cranial nerve involvement uncommon	Rare in Europe and North America, a substantial proportion (30–65%) in Asia and Central and South America	Axonal polyneuropathy, normal sensory action potential	GM1a/b, GD1a & GalNac-GD1a
Acute motor and sensory axonal neuropathy (AMSAN)	Severe muscle weakness similar to AMAN but with sensory loss	—	Axonal polyneuropathy, reduced or absent sensory action potential	GM1, GD1a
Pharyngeal-cervical-brachial variant	Weakness particularly of the throat muscles, and face, neck, and shoulder muscles	—	Generally normal, sometimes axonal neuropathy in arms	Mostly GT1a, occasionally GQ1b, rarely GD1a
Miller Fisher syndrome	Ataxia, eye muscle weakness, areflexia but usually no limb weakness	This variant occurs more commonly in men than in women (2:1 ratio). Cases typically occur in the spring and the average age of occurrence is 43 years old	Generally normal, sometimes discrete changes in sensory conduction or H-reflex detected	GQ1b, GT1a

hyporeflexia or areflexia characterizes the limb weakness; 10% of patients may have normal or brisk reflexes. Isolated or bilateral facial palsy is reported as an atypical variant of GBS.[25,26] CSF analysis shows albuminocytologic dissociation in about 50% of patients during the first week that increases to 75% by third week. The disease is generally monophasic but 7% of patients may have recurrence.[21]

Nerve Conduction Study Findings

AIDP: AIDP patients show features of demyelination. They have prolonged distal motor latency, decreased motor nerve conduction velocity, increased F-wave latency, conduction blocks, and temporal dispersion.

Axonal variety of GBS: These patients do not show features of demyelination (or, one demyelinating feature in one nerve if distal compound muscle action potential [CMAP] amplitude is $< 10\%$ of lower limit of normal). Distal CMAP amplitude is less than 80% of lower limit of normal in at least two nerves. Transient motor nerve conduction block may be present (possibly caused by antiganglioside antibodies).

General Care

Ideally, all GBS patients should remain in a critical care unit with facilities for respiratory and cardiac monitoring. Measures should be taken for early detection of complications such as sepsis, pulmonary embolism, and unexplained cardiac arrest. Artificial respiration may be required in patients with at least one major criterion or two minor criteria. The major criteria are hypercapnia (partial pressure of carbon dioxide > 48 mm Hg), hypoxemia (partial pressure of oxygen < 56 mm Hg while breathing ambient air) and vital capacity (VC) less than 15 mL/kg. The minor criteria are inefficient cough, atelectasis, and impaired swallowing.[27]

Prevention of Pressure Sores

Immobility of the patient favors pressure sores specially on buttocks area, heels of the feet, shoulders, and back of the head. These can be prevented by turning and repositioning the patient every 3 hours, providing soft padding in the pressure-areas, providing good skin care by keeping the skin clean and dry, and providing good nutrition. Ripple bed is a useful device for bedsore prevention. An external pump rotates the pressure in the different tube-like compartments of the mattress allowing pressure to alternate on the skin.

Nutrition

Malnutrition is an under recognized and under treated problem. Nutritional status in critically ill GBS patients can be difficult to assess. Anthropometric measurements like skin fold thickness and mid-arm circumference are not particularly useful in critically-ill patients. Weight change and serum albumin levels should be monitored at regular intervals. In general, around 1.5 to 2.0 g/kg/day of protein are required. Lipids should form about 40% of total calories. Carbohydrate should form around 20 to 25% of energy requirements. Adjustments must be made for fever and

sepsis if the patient develops complications. Micronutrients should be supplemented. Most GBS patients tolerate enteral nutrition. A decision to place a nasogastric tube should be made by early assessment of swallowing.[28]

Prevention of Deep Venous Thrombosis

Subcutaneous heparin and compression stockings should be used as prophylaxis against deep vein thrombosis.

Physiotherapy

Physiotherapy should be administered to the extremities to prevent contractures. Chest physiotherapy should be administered to clear the pulmonary secretions and to prevent collapse of the lung.

Dysautonomia in GBS

Dysautonomia is very characteristic of GBS. In a recently published article consisting of 214 GBS patients, 51 (31 %) presented dysautonomia. Hypertension was the most common (84.8 %) manifestation. Hypotension (76.1 %), tachycardia (76.1 %), need for vasopressor (58.7 %), and enteric dysmotility (76.1 %) were the other manifestations. Thirty-nine percent of these episodes occurred in demyelinating form of GBS and an equal number in axonal motor form of GBS. The need for mechanical ventilation and intensive care, lower cranial nerve involvement, higher modified Erasmus GBS outcome scale (mEGOS), Erasmus GBS respiratory insufficiency score (EGRIS), GBS disability score, and occurrence of delirium were the significant factors associated with dysautonomia. Dysautonomic patients needed longer duration to walk independently. There was no associated increase in mortality.[29]

In a series published from Mayo Clinic, out of 187 patients, 71 (38%) had at least one manifestation of dysautonomia. Dysautonomia was present in 36% of patients with AIDP. Hypertension, hypotension, tachycardia or bradycardia, ileus, fever, and urinary retention were very common manifestations. These patients also exhibited cardiogenic complications, higher GBS disability score, posterior reversible encephalopathy syndrome, and higher EGOS and syndrome of inappropriate antidiuretic hormone secretion.[30]

The results of autonomic testing in GBS patients were reported in a recent publication. Baroreceptor sensitivity and time-domain average RR interval were significantly poor in GBS patients. Active standing 30:15 ratio and cold pressor test were also considerably abnormal in GBS patients. The abnormalities of autonomic parameters normalized by 6 weeks.[31] There are quite a few reports of Takotsubo cardiomyopathy in GBS.[32]

Pain in GBS

Neuropathic pain in GBS could be quite disturbing. A systematic review of pain in GBS included four studies that evaluated gabapentin, carbamazepine, methylprednisolone, individually and one study that compared gabapentin with carbamazepine. Both gabapentin and carbamazepine were found to be useful for the treatment of pain. Gabapentin was more effective than carbamazepine. Methylprednisolone was not effective in treating pain.[33] Pregabalin can be effective in treating dysautonomia, as well as painful dysesthesia in GBS.[34]

Other General Care

Constipation and urinary retention can be treated by the use of laxatives and bladder catheterization, respectively. Early rehabilitation improves the possibility of favorable outcome.

Respiratory Care

About a third of patients with GBS develop respiratory failure. A decrease in VC with a decrease in maximal inspiratory pressure (PImax) characterizes respiratory muscle weakness. Poor cough causes inability to clear airway secretions and leads to atelectasis. Facial and oropharyngeal muscular weakness leads to aspiration pneumonia. The degree of respiratory muscle weakness correlates with the severity of limb weakness.[35] A VC lower than 20 mL/kg, PImax higher than 30 cm H_2O, peak expiratory pressure (PEmax) lower than 40 cm H_2O, or a VC decrease greater than 30% are associated with respiratory failure.[36] Bulbar dysfunction is an independent risk factor for respiratory failure.[36] In a large study including 722 patients, Sharshar et al identified six factors that are independently predictive of need for mechanical ventilation in GBS: less than 7 days from onset to admission, inability to stand, inability to cough, inability to lift the elbows, inability to lift the head, and liver enzyme elevation.[35] In another study, factors associated with the need for artificial ventilation are simultaneous motor weakness in upper and lower limbs as the initial symptom, upper limb power less than 3/5 at nadir, and bulbar weakness.[37]

EGRIS identified three parameters to predict the need for mechanical ventilation: Days between onset of weakness and admission, Medical Research Council (MRC) sum score, and presence of facial and/or bulbar weakness. The scoring system ranges from 0 to 7. An international cohort study validated the EGRIS score.[38]

Mechanical Ventilation in GBS

Noninvasive mechanical ventilation is unsafe in patients of GBS with impaired swallowing, ineffective cough, dysautonomia, and rapidly declining values of VC or PImax/PEmax.[39] Invasive ventilation is the choice when the patient requires respiratory support. One must remember that endotracheal intubation carries some risks; dysautonomia can induce severe hypotension or cardiac arrhythmias during intubation. Depolarizing muscle agents used to facilitate intubation can induce hyperkalemia and cardiac arrest. On the other hand, nondepolarizing muscle relaxants can prolong the neuromuscular block.

Choice of the mode of ventilation depends on the residual respiratory muscle power of the patient. Patients with very little muscle power are better ventilated in a control mode of ventilation. Pressure control mode is preferred over volume control mode because of the uniform distribution of ventilation. Patients with reasonably preserved ventilatory effort

may be ventilated in pressure support mode of ventilation with adequate pressure support. Adequacy of pressure support level can be judged by the patient's comfort and the respiratory rate while the patient is on ventilator.

Tracheostomy

Timing of tracheostomy has to be carefully judged. Early tracheostomy may improve patient's comfort and facilitate adequate oral hygiene, oral nutrition, and mobilization. At the same time, early tracheostomy may not be desirable in patients who improve rapidly. Delayed tracheostomy, on the other hand, may increase the tracheal tube-associated complications, such as tracheal stenosis or tracheomalacia. When prolonged ventilatory support is expected, tracheostomy is generally considered around 3 weeks.[40] A composite lung function indicator (PF score) based on summation of the VC (mL/kg), PEmax (cm H2O) and PImax (cm H2O) could be used to predict the need for ventilation of more than 3 weeks and consequently, a need for tracheostomy. If the ratio of the PF score on the 12th day of ventilation divided by the PF score on the day of intubation is less than one, the need for prolonged ventilation is predictable with good certainty.[41]

The weaning process from mechanical ventilation mainly depends on the recovery of VC and inspiratory force. Weaning can be commenced when the VC is more than 15 mL/kg. One should not predict weaning based on the limb muscle power. Complications while the patient is on ventilator include ventilator-associated pneumonia and deep venous thrombosis.[42]

Definitive Treatment

The definitive treatment for GBS, as of today, consists of plasma exchange (PE) or intravenous immunoglobulin (IVIG) therapy.

Plasma Exchange

Plasma exchange started within 2 weeks after the disease onset is found to be effective in hastening the recovery. It removes antibodies and complement. It results in faster improvement of the patient, when compared to supportive treatment alone.[43] A total of five plasma exchanges are done over a period of 2 weeks. In one trial, patients with mild weakness improved with two exchanges of 1.5 plasma volumes. Patients with more severe involvement require at least four exchanges. The Cochrane data base review published in 2017 attested to the efficacy of plasma exchange.[44]

Plasma exchange is a relatively safe and is usually well tolerated. Rare complications of plasma exchange include catheter-related events such as infections, pneumothorax while cannulating the central veins, and local bleeding.[45] The contraindications for therapeutic plasma pheresis are as follows: 1. Nonavailability of central line access or large bore peripheral lines, 2) hemodynamic instability or septicemia, 3) known allergy to fresh frozen plasma or replacement colloid/albumin, 4) known allergy to heparin, 5) hypocalcemia is a relative contraindication as it restricts the use of citrate as an anticoagulant during the procedure, and 6) angiotensin-converting enzyme inhibitor used in last 24 hours; a relative contraindication.[46]

Immunoglobulins

IVIG therapy started within 2 weeks of starting of the disease is as effective as plasma exchange.[47,48] Immunoglobulin neutralizes the antibodies and inhibits complement activation. The usual treatment regimen is a total dose of 2 gm/kg over a period of 5 days.[48] In severely unresponsive patients, a second course of IVIG has been tried.[49]

IVIG administration is generally a safe therapy. Side effects, even if they occur, are mild and transient. The immediate side effects include headache, flushing, malaise, chest tightness, fever, chills, myalgia, fatigue, dyspnea, back pain, nausea, vomiting, diarrhea, blood pressure changes, and tachycardia. Anaphylactic reactions may occur especially in immunoglobulin A (IgA)-deficient patients. Late side effects are rare and include acute renal failure, thromboembolic events, aseptic meningitis, neutropenia, and autoimmune hemolytic anemia, skin reactions, and rare events of arthritis. Pseudohyponatremia following IVIg is an important complication to be recognized.[50]

Contraindications for IVIG therapy are as follows: Sugar-stabilized IVIG products should be avoided in patients with renal failure or diabetes. Defer use of hyperosmolar IVIG products in post-transplantation patients due to the risk of renal failure and osmotic nephropathy. High sodium-containing products should be used cautiously for individuals with cardiac conditions and hypertension. Severe anaphylactic reactions are rare and have been reported when using IVIG products in patients with IgA deficiency. These patients have anti-IgA antibodies. Measles, mumps, and rubella vaccine should not be administered in children receiving IVIG therapy, as the immunoglobulin G could counter the attenuated virus in the vaccine preparation and render them inactive. Thus, vaccines should be delayed for at least 9 months after the IVIG therapy or vice versa.[51]

Comparison of PE and IVIG

Several studies compared PE with IVIG treatment in GBS. A Dutch study has proven that IVIG therapy is as effective or superior to plasma pheresis in certain aspects. With plasma exchange, one grade improvement in muscle power occurred in 41 days, while similar improvement took 27 days only with IVIG therapy. Fewer complications and less need for artificial ventilation were noticed with IVIG treatment.[48] A randomized trial of 383 patients, with a follow up of 48 weeks, compared PE with IVIG, and with a combined regimen of PE followed by IVIG. The study concluded that in severe GBS, both treatments have equal efficacy. No significant advantage was conferred by the combination of PE and IVIG.[47] In a study comparing the functional outcomes in neurorehabilitation, patients who received PE or IVIG showed a significant increase in total functional independence measure scores and a mean improvement in Guillain–Barré Disability Score. The length of stay in rehabilitation was similar with both treatments. There was no difference between the two treatments.[52] A Cochrane data base review showed that, in severe GBS, IVIG hastens recovery as much as PE; IVIG after PE

did not confer any extra benefit.[53] A second course of IVIG did not demonstrate any better outcome.[54] In a study published from India, among the three modalities of immunomodulatory treatment, namely large volume PE, IVIG and small volume PE, there was no significant difference in outcome.[55]

Role of Corticosteroids

According to a Cochrane database review, corticosteroids do not significantly hasten recovery from GBS or affect the long-term outcome. According to very low-quality evidence, oral corticosteroids delay recovery. Diabetes requiring insulin was more common and hypertension less common with corticosteroids based on high-quality evidence.[56]

Treatments Under Investigation

Eculizumab, erythropoietin, and Fasudil have shown promise in animal models of the GBS but clinical studies are lacking.[57] Eculizumab protects against complement-mediated damage in murine MFS.[58] Another rat study indicated a beneficial effect of selective blockade of Rho-kinase by Fasudil in animals with autoimmune inflammation of the peripheral nerves, and may provide a rationale for the selective blockade of Rho-kinase as a new therapy for GBS.[59] Another study found that erythropoietin completely reversed the inhibitory effects of antiganglioside antibodies on axon regeneration in cell culture models and significantly improved nerve regeneration/repair in an animal model.[60]

Seasonal Variation in GBS

Seasonal variation in the occurrence of GBS is reported across the world. A systematic review from oxford reported a 14% increased risk of GBS in winter compared to summer among 9836 patients from 42 studies.[61] Sriganesh et al observed seasonal variation in recovery from ventilatory support in GBS patients who were on mechanical ventilation. The recovery was fastest between March and May and slowest between December and February months.[62]

GBS in Pediatric Age Group

Consensus-based guidelines were attempted in pediatric GBS by German-Speaking Society of Neuropediatrics, supported by the Association of Scientific Medical Societies. There were not enough studies to draw definite conclusions. The important conclusions of the consensus are as follows: The diagnostic and therapeutic recommendations of GBS in children are largely dependent on findings in adult patients. The diagnostic approach is based on the clinical criteria and CSF and electrophysiological findings. Repetition of invasive procedures that yield ambiguous results is only recommended if the diagnosis cannot be ascertained from the other criteria. For persistently-progressive GBS, treatment with IVIG is recommended. In cases of IVIG intolerance or inefficacy, plasmapheresis is recommended. Corticosteroids are ineffective for GBS but can be considered only when acute onset chronic inflammatory demyelinating polyneuropathy is suspected.[63]

GBS in the Elderly

Striking features that are seen in elderly GBS patients ($>$ 60 years) are short duration of symptoms, more frequent facial palsy, hyponatremia, lower mean MRC sum score, and worse Hughes Disability Score. Autonomic dysfunction and need for mechanical ventilation are also more frequent in the elderly.[64]

Delirium in GBS

Delirium is not a frequent complication of GBS. However, in a single-center study, 12.9% of 154 GBS patients fulfilled the Diagnostic and Statistical Manual of Mental Disorders, Fifth edition criteria for delirium. Elderly patients, those with bulbar involvement, prolonged intensive care unit (ICU) stay, and those who needed mechanical ventilation are more likely to have delirium.[65]

Prognosis of GBS

Prognosis of GBS varies widely. Advanced age prognosticates a poor outcome. In one study, age more than 40 years and peroneal nerve conduction block predicted disability at 6 months.[66] The EGOS is a scoring system that predicts ability to walk independently after 6 months. The score uses age, presence of preceding diarrhea, and GBS disability score.[67] The mEGOS score utilizes age, preceding diarrhea, and MRC sum score at hospital admission and at 1 week to prognosticate the ability to walk at 4 weeks, 3 months, and 6 months[68] (►**Table 2**). Prolonged ulnar F-wave latencies and asymmetric muscle weakness prognosticated delayed walking in children with AMAN.[69]

Table 2 Modified Erasmus GBS outcome score (mEGOS) [77]

Prognostic factor	Score at hospital admission	Score at 1 week
Age at onset (years)		
$\leq$ 40	0	0
41–60	1	1
$>$ 60	2	2
Preceding diarrhea		
Absent	0	0
Present	1	1
MRC sumscore		
51–60	0	0
41–50	2	3
31–40	4	6
0–30	6	9
mEGOS	0-9	0-12

Abbreviations: GBS, Guillain–Barré syndrome; MRC, Medical Research Council.

The mortality in GBS was 12.1% in a series of 273 patients reported from India. The factors determining mortality were elderly age group, pulmonary complications, autonomic dysfunction, bleeding from any site, and hypokalemia. The risk of mortality increased 4.69 times with pneumonia, 2.44 times with hypokalemia, and 3.14 times with dysautonomia.[70]

Prognostication based on electrophysiological data was attempted in a series of 93 patients, the majority of whom had a demyelinating electrophysiology. Reduced amplitude or absent motor potentials and inexcitable sensory nerves were predictive of difficulty in weaning from the ventilator. Conduction blocks in motor nerves and the duration of ventilation were not correlated with outcome. Low amplitude of median nerve potential correlated with a poor outcome at hospital discharge.[71]

COVID-19 and GBS

Several GBS cases have been reported globally during recent pandemic of coronavirus disease 2019 (COVID-19). One multicentric study was published from the state of Maharashtra in India. It reported 42 patients with GBS and COVID-19. The mean age of the patients was 59 years. GBS was the presenting symptom in 14 out of 42 patients. Six patients remained asymptomatic for COVID-19 despite positive reverse transcription-polymerase chain reaction test. The median interval between COVID-19 and GBS was 14 days. Electrophysiological studies showed a demyelinating pattern of GBS in 25 out of 42 patients. Inflammatory markers were elevated in 35 patients. Thirty-eight patients had an abnormal high-resolution computed tomographic chest. Fourteen patients required ventilation. Nine patients died. IVIG was the mainstay of therapy in these patients.[72]

A meta-analysis of 16 case series of COVID-19 reported 147 patients with GBS. A total of 44.9 % were admitted to the ICU. Mechanical ventilation was required for 38.1% of patients. Most of these patients presented with hyporeflexia or areflexia, impairment of lower limb strength and sensation, upper limb strength and sensation, and somatic sensation. They showed increased CSF protein and albuminocytological dissociation. The most common variant of GBS was AIDP. The mortality among these patients was 10.9%.[73]

A systematic review was published associating COVID-19 vaccination with GBS. The data included 88 patients from 41 studies. AstraZeneca was the most-commonly reported vaccine (52 cases) causing GBS followed by Pfizer causing GBS in 20 cases. GBS manifested after the first dose of vaccine in the majority of patients after an average of 14 days. Sensory disturbance, limb weakness, and facial weakness were the most common symptoms reported. Albuminocytologic dissociation was seen in 65% of patients. AIDP was the commonest GBS subtype (43.2%). Intubation was required by one-fifth of patients and favorable outcome was reported in 63% of subjects.[74]

GBS in Pregnancy

In ICU, we may encounter an occasional pregnant patient with GBS. Lower segment cesarean section cannot be done without anesthesia as the patients have intact sensations. General or regional anesthesia is required.

Chan et al examined the maternal and fetal outcomes of 30 GBS cases with pregnancy. The risks of plasmapheresis were similar between pregnant and nonpregnant patients. The safety of IVIG during pregnancy has also been proven in this study. Of the 30 pregnant women, 10 required mechanical ventilation for a period ranging from 2 to 126 days. Recovery of maternal symptoms was not improved by termination of pregnancy. There was one case of neonatal GBS born to an affected mother that responded to IVIG treatment; the neonate recovered within 2 weeks. Uterine contraction was not affected by GBS and normal vaginal delivery was possible in 9 out of 30 patients. Therefore, operative delivery in GBS patients should be reserved for obstetric indications only. The choice of labor analgesia and anesthesia for cesarean section is a major concern. Both regional and general anesthesia have potential additional risks. The main problem with general anesthesia was the use of succinylcholine, which could cause hyperkalemia and cardiac arrest. Autonomic instability due to GBS may pose problems during general anesthesia. Of the 30 cases reviewed, 5 patients received uncomplicated regional anesthesia.[75]

Anesthesia in Patients Recovered from GBS

There is very little literature on anesthesia for patients who have recovered from GBS. Of the patients who do not succumb to the illness, 5% will have some permanent residual disabling neurological deficit. A further 65% will have some persistent minor problem. Only around 15% recover completely. Thus, the number of patients who have recovered from GBS seen in any one unit will be very small. There is a case report of cardiac arrest following administration of succinyl choline in patients who recently recovered from GBS.[76] Other than this there is no systematically collected data on anesthesia in patients who recovered from GBS.

Conclusion

Though GBS is a self-limiting disease whose recovery is hastened by PE or IVIG therapy, there are a few research questions that still remain to be answered. The mechanisms of demyelination versus axonopathy in different patients need to be explained. The cause and treatment of neuropathic pain have to be clearly understood. Biomarkers of poor prognosis in some patients must be identified early during the disease. The cause of seasonal variation in the occurrence and severity of illness has to be identified.

Conflict of Interest
None declared.

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